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MULTILAYER CIRCUIT BOARD WITH BUILT-IN ELECTRONIC COMPONENT, AND MANUFACTURING METHOD THEREOF

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MULTILAYER CIRCUIT BOARD WITH BUILT-IN ELECTRONIC COMPONENT, AND MANUFACTURING METHOD THEREOF
[Denshi buhin naizo-gata taso kairo oyobi sono seiho]

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[There are no amendments to this patent.]

Claims

1. A multilayer circuit board with a built-in electronic component characterized in that, in a multilayer circuit board with a built-in electronic component where the electronic component which is connected with inner layer wiring formed on the surface of a core insulating material is sealed with insulating resin for sealing, the area other than area of the insulating resin for sealing that seals the aforementioned electronic component is multilayered with an interlayer insulating layer and inner layer wiring, and the surface of the insulating resin for sealing that seals the aforementioned electronic component is also made multilayer by inner layer wiring and an interlayer insulating layer.

2. The multilayer circuit board with a built-in electronic component mentioned in Claim 1 where the aforementioned inner layer wiring is interconnected by via holes.

3. The multilayer circuit board with a built-in electronic component mentioned in Claim 1 where the aforementioned electronic component is a flat electronic component.

4. A manufacturing method for a multi-layer circuit board with a built-in electronic component that includes:

(A) a process for packaging the electronic component on inner layer wiring on the surface of a core insulating material, (B) a process for including lead terminals for the aforementioned electronic component and sealing it with insulating resin, (C) a multilayering process whereby a process for forming an interlayer insulating layer, connecting it with via holes, and then forming inner layer wiring by plating in the area other than the insulating resin that seals the aforementioned electronic component is repeated for the number of layers required, (D) a process for forming inner layer wiring on the insulating resin surface that seals the aforementioned electronic component, and (E) a process for furnishing outermost layer wiring by plating and simultaneously connecting it with the aforementioned inner layer wiring with a via hole.

Detailed explanation of the invention

[0001]

Industrial application field

This invention pertains to a multilayer circuit board applied to all types of electronic equipment and relates to a multilayer circuit board with a structure that has an electronic component built in.

[0002]

Prior art

In the past, electronic components have been packaged on the outmost layer wiring of multilayer circuit boards. Japanese Kokai Patent Application Nos. Hei 6[1994]-1206070 and Hei 6[1994]-1206071 disclose packaging an electronic component on the surface of a two-sided circuit board, connecting the two-sided circuit boards which is furnished with an area with an electronic component buried on top of that, by solder bumps, filling that area with resin, and further multilayering that area by further packaging an electronic component on the outermost layer wiring. With this method, while miniaturization of a multilayer circuit board including an electronic component, can be achieved, the multilayer circuit board is not thinned.

[0003]

Japanese Kokai Patent Application No. Hei 6[1994]-283867 discloses a so-called planed structure where a window through which an electronic component can be inserted is furnished in the multilayer circuit board, and the electronic component is inserted horizontally into this planed area and connected with the exposed inner layer wiring. The electronic component and multilayer circuit board are connected by soldering, solder paste, solder balls, wiring bonding, etc., and used according to the electronic component structure.

[0004]

Problems to be solved by the invention

Recently, various types of miniaturized, thinner, and lightweight electronic equipment have been developed. Examples include many [types of] electronic equipment, such as notebook personal computers, liquid crystal display devices, various types of wireless devices, telephones, video cameras, facsimiles, etc.

[0005]

Progress is also being made in miniaturizing multilayer circuit boards, on which the aforementioned electronic equipment items are mounted, and the packaged electronic components, and in making them thinner and lighter. For example, with card type multilayer circuit boards which are starting to be used for the aforementioned notebook type personal computers, it is predicted that the thickness, including the packaged electronic components, will continue to decrease.

[0006]

The planed structure multilayer circuit board disclosed in aforementioned Japanese Kokai Patent Application No. Hei 6[1994]-283867 is an effective method for decreasing the thickness, including the packaged electronic components. However, no wiring for the multilayer circuit board is formed in the planed area, so that portions of the wiring will have even more layers, or a means of forming the wiring by making the area larger cannot be avoided. That is, while the planed structure multilayer circuit board can be made lighter by the amount of the volume of the window furnished by planing, it has a limitation from the standpoint of thinning and miniaturizing.

[0007]

Also, there is the problem that when a window is formed with planing, if stress is applied, cracking occurs in the multilayer circuit board, or strain may be produced and warping occur due

to the heat of soldering when the electronic components are packaged. This has been an obstacle to achieving greater thinness.

[0008]

The objective of this invention is to provide a multilayer circuit board with an electronic component built in and a manufacturing method thereof that will solve the aforementioned problems.

[0009]

Means for solving the problems

The essential points of this invention for achieving the aforementioned objective are as follows. First, as shown in the schematic cross section in Figure 1, in a multilayer circuit board with a built-in electronic component where electronic component (3) that is connected with inner layer wiring (2a) formed on the surface of core insulating material (1) is sealed with insulating resin for sealing (4), this is a multilayer circuit board with a built-in electronic component where the area other than that of insulating resin for sealing (4) that seals the aforementioned electronic component (3) is multilayered with interlayer insulating layer (5a) and inner layer wiring (2b), and the surface of insulating resin (4) for sealing that seals the aforementioned electronic component (3) is also multilayered by inner layer wiring (2c) and interlayer insulating layer (5b).

[0010]

The manufacturing method for the aforementioned multilayer circuit board with a built-in electronic component is a manufacturing method for a multilayer circuit board with a built-in electronic component that includes: (A) a process for packaging electronic component (3) for inner layer wiring (2a) on the surface of core insulating material (1), (B) a process for sealing with insulating resin for sealing (4) that includes the lead terminal area of aforementioned electronic component (3), (C) a multilayering process whereby a process for forming interlayer insulating layer (5a) in the area other than that of insulating resin (4) that seals aforementioned electronic component (3), forming a via hole (6a) in that, and then forming inner layer wiring (2b) by plating repeated for the number of layers required, (D) a process where inner layer wiring (2c) is formed on the surface of insulating resin for sealing (4) that seals aforementioned electronic component (3), and (E) a process where outermost layer wiring (7) is furnished by plating and it is simultaneously connected with aforementioned inner layer wiring (2c) by a via hole (6b).

[0011]

For core insulating material (1), an insulating substrate, such as a glass epoxy substrate, polyimide substrate, or maleimide substrate generally used for multilayer circuit boards, can be used. If a copper-clad laminate of these is used, inner layer wiring (2a) can be formed by etching. And if an insulating substrate without copper foil is used, it can be formed by an additive method.

[0012]

For connecting electronic component (3) and inner layer wiring (2a), resin packaging with a J lead type or gull wing type lead frame is connected by solder paste with inner layer wiring (2a), or a bare chip can be connected with inner layer wiring (2a) with a solder ball, TAB system, or wire bonding.

[0013]

In Figures 1 and 2, an LSI is illustrated as the electronic component, but it goes without saying that many electronic components, such as capacitors or resistors, can be applied. In particular, this is most effective for electronic components with a flat structure.

[0014]

With this invention, the connected electronic component (3) is sealed with insulating resin for sealing (4). In this case, sealing is performed to cover the surface of electronic component (3). This is useful for ensuring adhesion with the resin that forms interlayer insulating film (5b) formed on top of it.

[0015]

A thermosetting type or ultraviolet hardened type resin can be used as insulating resin for sealing (4). Phenol resin, epoxy resin, phenoxy resin, polyimide resin, etc. are known as thermosetting types.

[0016]

For the ultraviolet hardened type, known types such as epoxy resins with cation polymerization, and photosensitive epoxy resins to which acrylic acid or methacrylic acid is added, or photosensitive polyimide resins with radical polymerization can be used.

[0017]

These resins are used by dissolving in a solvent along with thermosetting agents, photopolymerization initiators, etc., and mixing with microscopic filler, if necessary, to provide thixotropy and fluidity.

[0018]

These resins are formed in portions where they cover the electronic component and include the connection area by thick screen printing using a metal mask. Then, if they contain solvent, they are dried, and next hardened by heating, or irradiating with infrared light, an electron beam, or ultraviolet light, or by combined use of ultraviolet light and heating.

[0019]

For insulating resin for sealing (4), particularly in the case of bare chips, it is preferable that those with similar linear expansion coefficients be selected for both the resin and sealed component.

[0020]

As shown in Figure 1, to form inner layer wiring (2c) on the surface (top surface) of aforementioned insulating resin for sealing (4), irregularities can be formed in insulating resin for sealing (4) by dissolving with acid or an alkaline aqueous solution, and a filler that can ensure adhesion with inner layer wiring (2c) can also be mixed in. The filler mixing is useful for improving the modulus of elasticity of insulating resin for sealing (4) and decreasing the linear expansion coefficient.

[0021]

Next, interlayer insulating layers (5a) in which a via hole (6a) can be formed are formed in the area other than that of electronic component (3) that is sealed with insulating resin for sealing (4). In this case, it is important that the thickness of interlayer insulating layers (5a) be essentially the thickness of the resin that seals electronic component (3). The reason is that it is important to prevent a level difference or variation in thickness when interlayer insulating layer (5b) is further furnished on the surface, and for forming microscopic outermost layer wiring (7) precisely.

[0022]

As the resin for aforementioned interlayer insulating layer (5a), a thermosetting type, such as epoxy resin, phenoxy resin, polyimide resin, etc., or ultraviolet hardened resin can be used.

Since inner layer wiring (2b) will be formed by plating after via hole formation, a filler or rubber component may be mixed into these resins to ensure adhesion with the plating film.

[0023]

As the formation method for interlayer insulating layer (5a) into which those are mixed, when the resin is liquid, roll coating, curtain coating, screen printing, etc. can be used. When the resin for interlayer insulating layer (5a) is a film, it can be formed with a laminating method with a crimp roller.

[0024]

When the resins are thermosetting types, via hole (6a) is formed with a laser or drill after hardening. When they are ultraviolet hardened types, while it can be formed with a laser, via hole (6a) is generally formed by light exposure and developing.

[0025]

In this way, interlayer insulating layer (5a) that has via hole (6a) can be formed in the area other than that of electronic component (3) that is sealed with insulating resin for sealing (4). After via hole (6a) is formed in interlayer insulating layer (5a), inner layer wiring (2b) is formed on the inner wall of via hole (6a) and the surface of interlayer insulating layer (5a) by plating.

[0026]

By repeating the process of forming interlayer insulating layer (5a), forming via hole (6a), and forming wiring by plating for the number of layers required, the area other than where the electronic component is sealed can be multilayered. This multilayering can be applied up to the height of the insulating resin that seals electronic component (3).

[0027]

Next, inner layer wiring (2c) is formed on the surface of insulating resin for sealing (4) that seals electronic component (3) and on the surface of the interlayer insulating layer by plating.

[0028]

Finally, interlayer insulating layer (5b) is formed on the surface of that in order to form outermost layer wiring (7). In this case, the same resin used in forming interlayer insulating layer (5a) may be used, or a different resin may be used. Then after via hole (6b) is formed, outermost layer wiring (7) is formed by plating in the same way as described above, and it is connected with

inner layer wiring (2b) by via hole (6b). A multilayer circuit board with a built-in electronic component is obtained in this way.

[0029]

With the aforementioned process, when inner layer wirings (2b) and (2c) are formed by plating, it goes without saying that the interlayer insulating layer surface and the sealing insulating resin surface can be roughened to ensure adhesion with the plated wiring.

[0030]

As the roughening method, a method where the surface is roughened by liquid honing and then the exposed filler is dissolved with acid or an alkaline aqueous solution to roughen it, or a method where it is roughened using a chrome sulfate mixed solution or permanganic acid aqueous solution as the oxidant can be applied.

[0031]

As the method for forming wiring by plating, etching or an additive method that is the same as the method for forming inner layer wiring (2a) on the surface of core insulating material (1) as described above is used. In this way, inner layer wirings (2b) and (2c) can be formed on the surface of interlayer insulating layers (5a), and outermost layer wiring (7) and inner layer wirings (2a), (2b) and (2c) can be connected by via holes (6a) and (6b).

[0032]

Operation

With this invention, by furnishing inner layer wiring on the surface of the core insulating material directly beneath the electronic component, in the area other than the area of the insulating film that seals the electronic component, and even on the surface of the sealing insulating resin, wiring density can be markedly improved.

[0033]

Also, by making the thickness of the interlayer insulating layers essentially equal to the insulating resin for sealing, there will be no level difference in the interlayer insulating layers and no variation will occur. So it will be easy to make the outermost layer wiring microscopic and higher density in the outermost layer wiring can be achieved because of this.

[0034]

The number of layers can be reduced by increasing the wiring density, so miniaturization, greater thinness, and lighter weight can be achieved. Thus less thickness can be achieved than existing multilayer circuit boards in which electronic components are packaged.

[0035]

Also, because it a planed structure such as in the past is not formed, cracking in the multilayer circuit board caused by external force can be prevented. In addition, there is little strain accompanying the heat of soldering when the electronic component is packaged, so no warping occurs. Thus, separation of electronic component connection parts, plated wiring, and via hole portions that accompany warping can be prevented and connection reliability is increased.

[0036]

And in addition, the structure is such that the electronic component is sealed with insulating resin and is tightly adhered to the interlayer insulating layer formed on said sealed electronic component. So the reliability of the electronic component to resist moisture is also improved.

[0037]

Application examples

Below, this invention is explained using the schematic cross sections in Figures 1 and 2. Here, a case where there is formation on one side is shown in Figures 1 and 2, but formation on both sides is also possible.

[0038]

Application Example 1

Figure 1 showing this application example is a schematic cross section of a multilayer circuit board with a built-in electronic component. A bare chip, which is electronic component (3), is connected by solder balls (8) with the connection pad parts of inner layer wiring (2a) (18 μm thick) on core insulating material (1) (0.2 mm thick glass epoxy substrate: FR5).

[0039]

Electronic component (3), including the connected area, is sealed with insulating resin for sealing (4), which is composed of thermosetting polyimide resin into which aluminum hydroxide is mixed, so that the component surface is covered. Resin for sealing (4) is formed by thick screen printing. The sealing insulating resin is formed to be 0.55 mm thick after hardening.

[0040]

The characteristics of this application example are that two layers of interlayer insulating layer (5a) and inner layer wiring (2b) are formed in the area other than where insulating resin for sealing (4) seals electronic component (3), and that inner layer wiring (2c) is also formed on the surface of insulating resin for sealing (4). The diameter of via hole (6a) is 150 μm each.

[0041]

Interlayer insulating layers (5a) on which the two layer inner layer wiring is formed are made of calcium carbonate and aluminum hydroxide mixed into thermosetting epoxy resin. Via hole (6a) is formed by irradiating with carbon dioxide gas laser light.

[0042]

The plating of inner layer wiring (2c) on the surface of interlayer insulating layer (5b) and sealed insulating resin for sealing (4) the plating and of via hole (6a) are formed by roughening with liquid honing and then roughening with permanganic acid aqueous solution, and additionally, dissolving filler with an aqueous hydrochloric acid solution followed by electroless copper plating. The plating thickness is 15 μm each.

[0043]

Interlayer insulating film (5b) that is formed on the surface of insulating resin for sealing (4) is composed of aluminum hydroxide mixed into photosensitive epoxy resin with 50% of the epoxy groups left, and is formed by screen printing. The thickness of interlayer insulating film (5b) is 50 μm.

[0044]

Via hole (6b) is formed by developing after exposure with an aqueous solution of an alcohol solvent diluted with water, and the diameter is 50 μm. The plating of via hole (6b) that connects outermost layer wiring (7) and inner layer wiring (2c) is formed in the same way as inner layer wiring (2b). The plating thickness is 15 μm.

[0045]

The multilayer circuit board with an electronic component built-in that is this application example has a total of 8 wiring layers and its total thickness is about 2.4 mm.

[0046]

Application Example 2

Figure 2 showing this application example is a schematic cross section of a multilayer circuit board with a built-in electronic component. TAB structure electronic component (3), which is composed of a thin-film polyimide film on which a bare chip is mounted, is connected to a connection pad part of inner layer wiring (2a) (18 μm thick) of core insulating material (1) (0.1 mm thick glass epoxy substrate: FR5).

[0047]

The surface of electronic component (3), including the connected area, is sealed with thermosetting epoxy resin (4) to be covered. Insulating resin for sealing (4) is formed by four passes of metal mask thick screen printing. The thickness of the sealing resin after hardening was 0.9 mm.

[0048]

The characteristics of this application example are that two layers of inner layer wiring (2a) and (2b) are formed in the portions other than the area of insulating resin for sealing (4) that seals electronic component (3), as in Application Example 1.

[0049]

The diameter of each via hole (6a) is 120 μm. Interlayer insulating layers (5a) on which the two layer wiring is formed are composed of calcium carbonate and aluminum hydroxide mixed into thermosetting epoxy resin, and the via holes are formed by drilling.

[0050]

The plating of inner layer wiring (2c) on the surface of interlayer insulating layer (5a) and sealed insulating resin for sealing (4), and the plating of via hole (6a) are formed by roughening with liquid honing, then roughening with a chrome sulfate mixed solution, additionally dissolving the filler with an aqueous sulfuric acid solution, and then by only electroless copper plating. The plating thickness is 15 μm each.

[0051]

Interlayer insulating layer (5b) is formed on the aforementioned surface by screen printing using aluminum hydroxide mixed into a photosensitive epoxy resin with 50% of the epoxy groups left. The thickness of interlayer insulating layer (5b) is 50 μm.

[0052]

Via hole (6b) is developed after exposure with an aqueous solution of an alcohol solvent diluted with water, and its diameter is 50 μm. The plating of via hole (6b) that connects outermost layer wiring (7) and inner layer wiring (2c) is formed in the same way as inner layer wiring (2b). The thickness is 15 μm.

[0053]

The multilayer circuit board with an electronic component built-in which is this application example has 8 wiring layers and the total thickness was about 2 mm.

[0054]

Effect of the invention

With this invention, the thickness of a multilayer circuit board, including the electronic component, can be decreased, so it is possible to obtain one that can be inserted into a narrow space in electronic equipment. Miniaturization, greater thinness, and lighter weight for electronic equipment can be sufficiently accommodated by this.

[0055]

Also, no cracking in the multilayer circuit board caused by external stress or warping accompanying the heat of soldering when the electronic component is packaged will occur. So thin multilayer circuit boards can be reliably supplied, and reliability for packaged electronic component can be improved.

[0056]

In addition, a structure where the electronic component is sealed with insulating resin is used, and tight adhesion due to the interlayer insulating layers exists, so the reliability of moisture resistance in the electronic component is improved. For this reason, the invention can be applied to household electronic equipment items that require a moisture-proofing structure, for example, air conditioners, refrigerators, freezers, washing machines, and pumps, and also to electronic equipment items that would be damaged by water, such as liquid crystal display devices, televisions, telephones, personal computers, facsimiles, etc. It is particularly suitable for electronic equipment items that are also used in rainy weather, such as outdoor cameras, video cameras, wireless telephones, etc.

Brief description of the figures

Figure 1 showing Application Example 1 is a schematic cross section of an electronic component built-in type multilayer circuit board.

Figure 2 showing Application Example 2 is a schematic cross section of an electronic component built-in type multilayer circuit board which is application example 2.

Explanation of symbols

(1) ... core insulating material, (2a), (2b), (2c) ... inner layer wiring, (3) ... electronic component, (4) ... insulating resin for sealing, (5a), (5b) ... interlayer insulating layer, (6a), 6b) ... via hole, (7) ... outermost layer wiring, (8) ... solder ball.

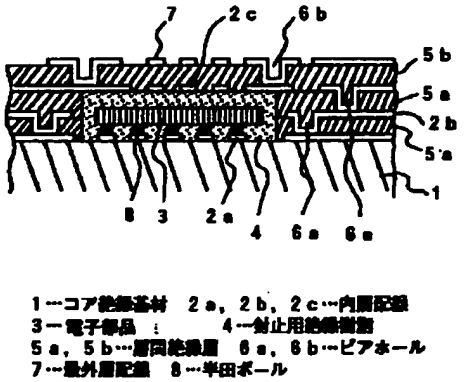

Figure 1

Legend:

1	Core insulating material
2a, 2b, 2c	Inner layer wiring
3	Electronic component
4	Insulating resin for sealing
5a, 5b	Interlayer insulating layer
6a, 6b	Via hole
7	Outermost layer wiring
8	Solder ball

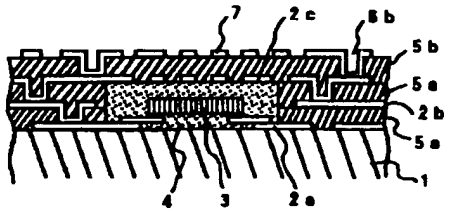

Figure 2